

# Introducing the U.S. Cyberlearning Community

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**Abstract.** The term “Cyberlearning” is used in the United States to describe a community of researchers, largely funded by the US National Science Foundation, who are exploring the integration of computer science research with learning sciences research. The Cyberlearning community is parallel to the EC-TEL community and the purpose of this poster is to foster mutual engagement between the communities. The paper describes the origin of the term, the conception of the field, the kinds of research being conducted, and some of the exemplary projects. The paper will also introduce the Center for Innovative Research in Cyberlearning (CIRCL), which is the hub of the knowledge network (research community) for cyberlearning and hosts a useful collection of resources.

**Keywords:** Innovation · Learning · Technology

## 1 Introduction

Researchers in the United States have begun using the term “Cyberlearning” to describe a portfolio of early-stage, conceptual projects. The projects collectively aim to tightly intertwine emerging technology with recent progress in the learning sciences to enable a broader diversity of people to learn advanced content. A group of US-based researchers engaged in this work intends to participate in the EC-TEL meeting in order to exchange ideas with like-minded European researchers; this paper is intended to lead to a poster at EC-TEL which would encourage interchange.

The term “cyberlearning” was coined in a 2008 report [1], which identified that advancing network technologies could enable ambitious designs for learning to break out of conventional school-based learning structures. The report advocated for 7 priorities: (1) advance seamless cyberlearning across formal and informal settings, (2) seize the opportunity for remote and virtual laboratories, (3) investigate virtual worlds and mixed-reality environments, (4) institute programs and policies to promote open educational resources, (5) harness the scientific-data deluge, (6) harness the learning-data deluge, and (7) recognize cyberlearning as a pervasive NSF-wide strategy.

Cyberlearning was defined (somewhat vaguely) as “learning that is mediated by networked computing.” The referent was to “cyberinfrastructure” – a term in use in the United States and which is parallel to the European “e-science.” The term was not intended to relate to “cyber-crime” or “cyber-security.” The report task force urged researcher to go beyond behind the typical classroom computers and to address mobility, sensors, augmented reality, big data, and other new affordances of technology.

The term led to a National Science Foundation funding program called “Cyberlearning: Transforming Education” (CTE) in 2011. CTE [2] further refined the definition of cyberlearning to take it beyond simply using educational technology tools and emphasized “integrating advances in technology with advances in what is known about how people learn” – that is, a strong emphasis on learning sciences research in conjunction with a focus on emerging technologies. In addition, CTE added a focus on “populations not served well by current educational practices,” to address issues of equity and diversity and was very deliberately defined to span informal and formal learning environments.

A research summit (see <http://circlcenter.org/events/summit-2012/>) was held in 2012 and helped to launch the nascent field. With regard to the emphasis on equity, Todd Rose gave a talk that has now become a book; the theme was needing to move beyond the implicit notion of a typical, normal, or average student to fully embrace the diversity of how people learn [3]. Many presentations shared emerging forms of technology, such as expansion of making to include digital fabrics, tangibles and ink-based circuitry. With regard to learning, many presentations focused on how learners’ *identities* changed as they participated in new experiences. The summit helped to define cyberlearning as tackling new ways of working with the diversity of students; exploring the new activities with forms of user experience; and as focused on newer theoretical constructs such as embodied learning and development of identity.

Since 2012, the Cyberlearning portfolio has grown to include over 250 projects. Prominent themes of Cyberlearning projects include mobile learning, bridging informal and formal learning, making and creating, citizen science, collaborative learning, embodied learning, data visualization, games and virtual worlds, augmented reality/immersive environments, virtual and remote labs, learning analytics and adaptive learning. This portfolio is already having an important impact in the United States – for example, it has been featured in the U.S. National Educational Technology Plan [6] to illustrate to educators how technology is moving beyond school installations of educational technology. In addition, following up on a recommendation in the task force report [1], the Center for Innovative Research in Cyberlearning (CIRCL, <http://circlcenter.org>) was created to serve as a community hub, similar to a European knowledge network like Kaleidoscope, Prolearn, or the other TEL-related coordination efforts. CIRCL acknowledges that research in the Cyberlearning portfolio has many parallels in European TEL work and thus is organizing a group of Cyberlearning researchers to attend EC-TEL to engage in scientific exchange.

## 2 Explorations of Immersion and Augmented Reality

Here we describe one fertile area that would be ripe for mutual exploration with European colleagues: immersive, augmented, and virtual reality projects. Individual projects in the Cyberlearning portfolio are exploring how technology can lead to experiences where students either feel more immersed in a context for scientific investigation or use technology to otherwise augment their actual context for learning.

In RoomQuake [4], students become immersed in a classroom-sized simulation of an earthquake. As the sounds of an earthquake play on speakers, the students can take readings on “seismographs” at different locations in the room, inspect an emerging fault line, and stretch twine to identify the epicenter. No real seismographs are used, rather tablet computers are used to simulate the measurement instruments and to reveal imaginary cracks in an otherwise normal classroom wall. Nonetheless, the experience is intense enough that students feel transported out of their classroom and begin working together like scientists in the field. Students must decide what to measure and how to analyze data in order to solve a challenging problem. In other classroom-scale immersive simulations, students travel inside a rocket to the moon or uncover an (imaginary) invasion of insects making a habitat in the walls of the classroom.

In contrast, in the “In Touch with Molecules” project [5] students manipulate a physical ball-and-stick model of a molecule such as hemoglobin, while a camera senses the model and visualizes it with related scientific phenomena, such as the energy field around the molecule. Students simultaneously see the molecule that they are physically moving and a visualization of the molecule on a screen, with colorful dynamic energy fields. Students’ embodied and tangible engagement with a physical model is thereby connected to more abstract, conceptual models, supporting students’ growth of understanding.

Whereas the first two examples take place in a school, the Connected Worlds [6] exhibit re-uses a large space remaining from the 1964 New York World’s Fair. Participants enter this space, which is now part of the New York Hall of Science (a science museum), and find a series of large screens simulating a set of connected ecological niches, each with fanciful simulated flora and fauna. The simulated work responds to how people move and gesture near the screens. For example, one full body gesture can cause a new tree to sprout. In addition, participants can move foam “rocks” and thus redirect the water supply to different ecological niches. As a consequence of these changing water available trajectories, life forms may die off, become more profuse, or migrate across the screens representing the ecological niches.

Other forms of augmented, immersive or virtual realities are also explored in Cyberlearning projects. In one project, students wear personal activity sensors and data flows to an online video game about health. Remote scientific laboratories are another type of virtual experience explored both in cyberlearning and European-based TEL projects. Multimodal input using a variety of sensors that can capture speech, body movement, touch, and other forms of expression and related emerging analytics techniques to interpret that data feature across many projects. In addition, projects explore how computer-generated output can be embedded in the real environment (as robots) or virtual environment (as avatars) in forms that do not seem as computer-like.

### **3 Discussion of Themes of Learning, Computation, and Equity**

We anticipate that by sharing examples of cyberlearning research, and through learning about related EC-TEL research by participating at the conference, researchers from the United States and Europe will be able to engage on topics of mutual interest. For example, we have already had several successful exchanges between the US-based and

Israel-based researchers regarding virtual reality and augmented reality learning, and this has led to fertile discussion about “empathy,” activity design, and desired platform capabilities. Three broad areas for discussion are:

1. **Diversity and Equity.** How can learning activities designed with emerging technologies enable new forms of participation and engagement that draw a broader population into opportunities for important learning?
2. **Forms of Interaction and Forms of Data.** What are the computational challenges in allowing activity developers to design new forms of interactive learning using these emerging capabilities (e.g. immersive, augmented, and virtual features)? How can we collect and work with the rich, multi-modal data that results?
3. **Frontiers for Learning Research.** What are the new research questions about learning that become important and addressable in these environments? What existing learning sciences methods and theories continue to be applicable, and how can research inform development of new theory or methodology development and growth?

**Acknowledgement.** This material is based upon work supported by the U.S. National Science Foundation under grants IIS-1233722, IIS-1441631, and IIS-1556486. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

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